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# Cougar Creek Water Quality Survey
September 1986

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## ABSTRACT

A water quality survey was performed on the Cougar Creek drainage during both dry and rainy conditions. Water quality problems were found to result from: poor quality water originating in a marsh, discharges at r.m. 2.76 and 1.59, and runoff of storm water from parking lots and ditches.


## INTRODUCTION

The Southwest Regional Office (SWRO) of the Department of Ecology requested a water quality survey be conducted on Cougar Creek.

This request included the following objectives:

- Locate unknown point discharges in Cougar Creek between river mile (r.m.) 1.6 and the origin, quantify their impacts, and attempt to identify their sources.
- Assess land use and attempt to identify potential non-point sources of pollution.

### Site Description

Cougar Creek (stream length = 3.5 mi.; drainage area = 2.52 sq. mi.) is a small tributary to the Salmon Creek (Class A stream) in Clark County (Figure 1). Cougar Creek flows through farmland, residential areas, and the northern suburbs of Hazel Dell. The elevation change between the origin and its confluence with Salmon Creek is about 200 feet.

### Background

Since 1981, numerous pollution events have occurred in Cougar Creek. Several times each year the stream turns a milky color which persists for several hours (SWRO, 1981-1986). Recently the stream turned blue and remained that color for some time. No sources for these events have been identified to date.

According to the Washington State Department of Fisheries (WDF), fish have not inhabited Cougar Creek stream in recent years (WDF, 1986).

## METHODS

On September 15, 16, and 17, 1986, a land-use assessment and stream survey was conducted. Sampling stations and descriptions are presented in Table 1. Main channel stations are designated by "r.m." Discharges are identified by r.m. number followed by the letter "D."

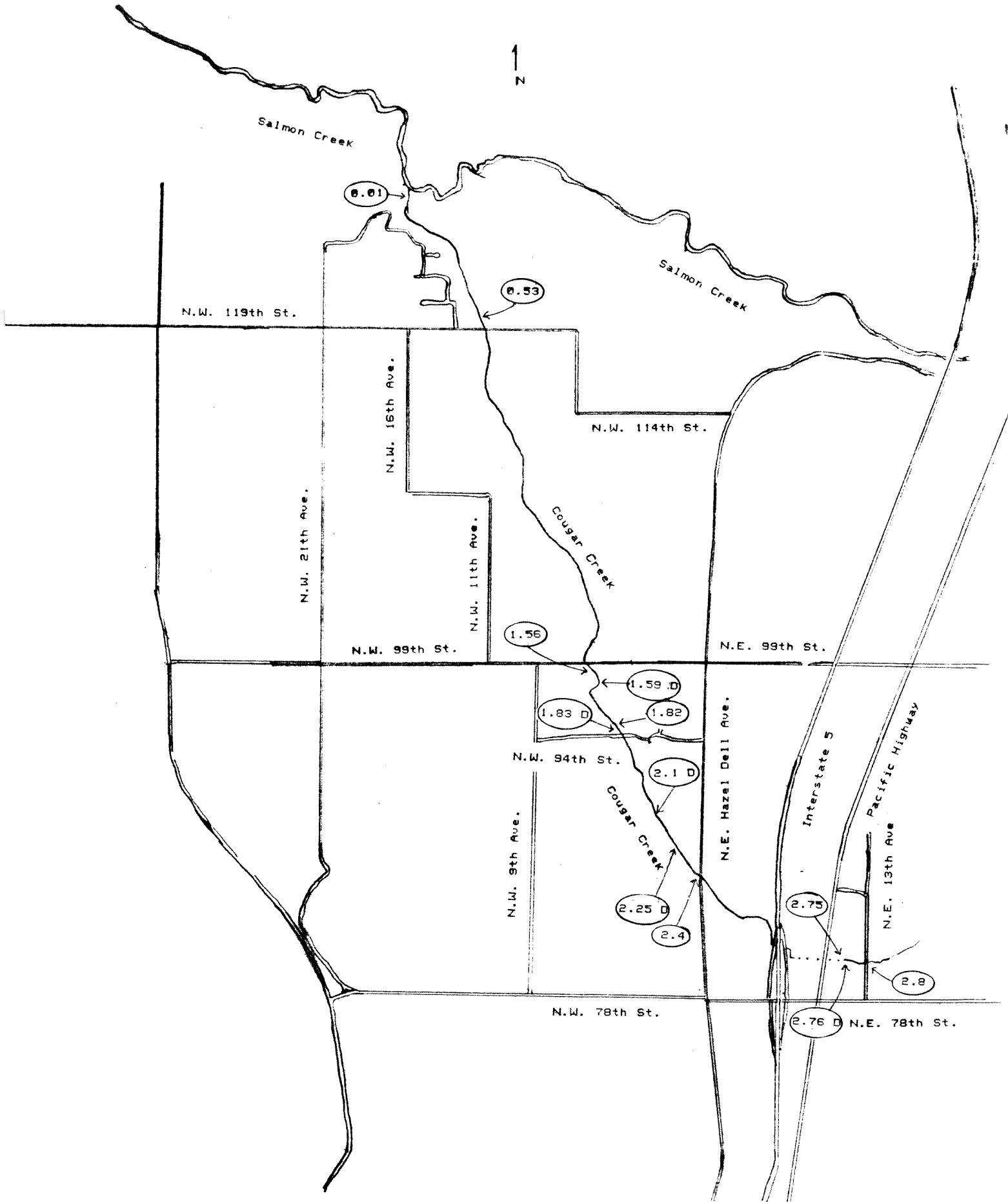


Figure 1. Cougar Creek Sample Stations
Sept. 1986

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68 mm = 1mile

Table 1. Station descriptions for the September 16, 17, and 18, 1986, Cougar Creek stream survey and pipes observed but not sampled.

| Station Symbol | River Mile | Station Description |
|---|---|---|
| 2.8 | 2.8 | Upstsream side of N.E. 13th Avenue culvert. |
| 2.76D | 2.76 | Twelve-inch aluminum corrugated culvert on left bank about five feet upstream from station 2.75. |
| 2.75 | 2.75 | Main channel station 150 feet east of the old Pacific Highway on the east side of the bank parking lot. |
| 2.4 | 2.4 | Main channel station on downstream side of N.E. Hazel Dell Avenue. |
| 2.25D | 2.25 | Thirty-inch concrete drain pipe on left bank approximately 800 feet downstream from station 2.4. |
| 2.1D | 2.1 | Twelve-inch aluminum corrugated culvert on left bank near public access about 100 feet downstream from the point that the BPA power lines cross over the creek. |
| 1.83D | 1.83 | Twelve-inch aluminum corrugated culvert on left bank on downstream side of N.W. 94th Street. |
| 1.82 | 1.82 | Main channel station about 50 feet downstream from N.W. 94th Street. |
| 1.79 | 1.79 | Twelve-inch pipe on the right bank. |
| 1.65 | 1.65 | Twelve-inch galvanized corrugated culvert on the left bank. |
| 1.64 | 1.64 | Four-inch PVC pipe on the left bank. |
| 1.62 | 1.62 | Twelve-inch cement culvert and three-inch plastic pipe on the left bank. |
| 1.59D | 1.59 | Twelve-inch aluminum corrugated culvert on the right bank about 150 feet upstream from the N.W. 99th Street. |
| 1.56 | 1.56 | Main channel station about 50 feet upstream from N.W. 99th Street. |
| 0.53 | 0.53 | Main channel station about 150 feet downstream from N.W. 119th Street. |
| 0.01 | 0.01 | Main channel station about 50 feet from the confluence of Cougar and Salmon Creeks. |

Flow measurements were made using a Marsh-McBirney magnetic flow meter at the main channel stations. When physical conditions allowed, small discharges were measured by recording the time required to fill a container of known volume (a 500-milliliter bottle/4-liter bucket) or estimated when actual measurement was not possible. Temperature, pH, and conductivity measurements were taken in the field. Samples for dissolved oxygen (D.O.) were fixed in the field and subsequently analyzed in the field laboratory. Samples for chemical oxygen demand (COD), biological oxygen demand (BOD), fecal coliform (F.C.), pH, conductivity, turbidity, chloride, and nutrients were collected, stored in the dark on ice, and returned to Olympia each night. The samples were transported to the Manchester laboratory on the day following collection.

## RESULTS AND DISCUSSION

No appreciable rain had fallen for several days prior to the survey. A significant rain event occurred during the September 17 visit (Table 2).

Table 2. Rainfall in the vicinity of Hazel Dell, September 1986 (City of Battle Ground, 1986).

| From 0800 | To 0800 | Inches of Precipitation |
|---|---|---|
| 9/14 | 9/15 | <0.01 |
| 9/15 | 9/16 | 0.02 |
| 9/16 | 9/17 | 0.09 |
| 9/17 | 9/18 | 0.83 |

### Cougar Creek above r.m. 2.75

Cougar Creek originates in a 20-acre marsh located about 0.1 mile upstream from r.m. 2.8. A farm with 10 to 30 cows was located just east of the marsh. Although these animals did not appear to have direct access to the marsh, storm runoff from the pasture does drain directly to the marsh. The south side of the marsh was bounded by an apartment complex and several fairly new small industries which had been constructed on former marsh lands. One company adjacent to the marsh was dumping fill dirt into the marsh at the time of the survey, but other less appropriate materials may be present. The north and west sides of the marsh were bounded by older medium-density residential houses.

All homes and businesses in this area are supposed to be on sewer (Clark County Public Sewer District [CCPSD], 1987).

All water quality results are presented in Tables 3a and 3b. During the low-flow portion of the survey (September 16), F.C., nitrate, and

Table 3a. Cougar Creek Survey - September 1986, analytical results.

| | | | | Field Data | | | | | | Laboratory Data | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Station | River Mile | Date | Time | Flow (cfs) | Temperature (°C) | pH (S.U.) | Conductivity (umhos/cm) | Dissolved Oxygen (mg/L) | Percent Saturation | pH (S.U.) | Conductivity (umhos/cm) | Turbidity (NTU)* | Fecal Coliform (org/100 mL) | Chemical Oxygen Demand (mg/L) | Chloride (mg/L) | $NO_3$-N (mg/L) | $NO_2$-N (mg/L) | $NH_3$-N (mg/L) | O-$PO_4$-P (mg/L) | T-$PO_4$-P (mg/L) |
| 2.8 | 2.8 | 9/16 | 1350 | -- | 13.1 | 7.4 | 261 | 8.2 | 78 | 7.5 | 273 | 5 | 2,000 | 21 | 5.2 | 2.20 | 0.01 | 0.02 | 0.08 | 0.14 |
| | | 9/17 | 1540 | -- | 13.7 | 6.7 | 148 | 6.8 | 65 | 7.0 | 179 | 22 | 7,800 | 37 | 4.1 | 0.61 | 0.02 | 0.04 | 0.08 | 0.20 |
| 2.76D | 2.76 | 9/17 | 1530 | -- | 18.6** | 5.9 | 112 | 6.1 | 65 | 6.0 | 113 | 3 | 79,000 | 130 | 3.7 | 1.00 | 0.03 | 0.37 | 0.13 | 0.20 |
| 2.75 | 2.75 | 9/16 | 1145 | 0.03 | 13.3 | 7.2 | 276 | 5.9 | 56 | 7.3 | 268 | 5 | 880 | 12 | 5.2 | 1.60 | 0.02 | 0.02 | 0.07 | 0.10 |
| | | 9/17 | 1525 | -- | 14.6 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| 2.4 | 2.4 | 9/16 | 1140 | 0.05 | 13.3 | 7.0 | 276 | 7.0 | 66 | 7.5 | 260 | 2 | 730 | 21 | 5.7 | 0.61 | 0.01 | 0.03 | 0.11 | 0.13 |
| | | 9/17 | 1245 | 1.40 | 15.7 | 6.4 | 74 | 6.8 | 68 | 6.9 | 84 | 5 | 8,400 | 54 | 1.7 | 0.41 | 0.03 | 0.20 | 0.08 | 0.17 |
| 2.25D | 2.25 | 9/17 | 1230 | 0.002 | 17.0 | 6.4 | 32 | -- | -- | 6.5 | 35 | 3 | 1,600 | 33 | 0.1 | 0.28 | 0.03 | 0.09 | 0.10 | 0.15 |
| 2.1D | 2.1 | 9/17 | 1220 | 0.002 | 15.7 | 4.7 | 33 | 9.4 | 94 | 6.0 | 31 | 3 | 440 | 50 | 0.5 | 0.20 | 0.02 | 0.13 | 0.06 | 0.10 |
| 1.83D | 1.83 | 9/17 | 0925 | -- | 14.9 | 5.4 | 36 | -- | -- | 4.9 | 34 | 6 | -- | 99 | 0.6 | 0.24 | 0.02 | 0.36 | 0.11 | 0.17 |
| 1.82 | 1.82 | 9/16 | 1540 | -- | 12.8 | 7.1 | 232 | 8.9 | 84 | 7.2 | 226 | 2 | 200 | 12 | 5.0 | 1.40 | <0.01 | 0.01 | 0.07 | 0.09 |
| | | 9/17 | 0920 | -- | 13.8 | 6.5 | 200 | 7.4 | 71 | 6.3 | 199 | 3 | 1,900 | 70 | 11.0 | 1.10 | 0.02 | 0.19 | 0.10 | 0.16 |
| 1.59D | 1.59 | 9/16 | 1440 | 0.07 | 12.1 | 7.1 | 236 | 9.8 | 91 | 7.3 | 225 | 4 | 1,800 | 12 | 6.4 | 2.10 | 0.01 | 0.01 | 0.08 | 0.15 |
| 1.56 | 1.56 | 9/16 | 1040 | 0.19 | 12.1 | 6.8 | 248 | 9.6 | 89 | 7.6 | 223 | 2 | 810 | 12 | 6.1 | 1.70 | 0.01 | 0.02 | 0.07 | 0.09 |
| 0.53 | 0.53 | 9/16 | 1000 | 0.91 | 10.3 | 6.9 | 248 | 10.8 | 96 | 8.0 | 235 | 1 | 170 | 8 | 6.1 | 3.00 | 0.01 | <0.01 | 0.09 | 0.11 |
| 0.01 | 0.01 | 9/16 | 0905 | 1.00 | 11.1 | 5.8 | 240 | 11.1 | 100 | 8.1 | 238 | 1 | 190 | 8 | 6.4 | 3.10 | <0.01 | <0.01 | 0.10 | 0.11 |
| | | 9/17 | 0855 | 1.10 | 12.3 | 6.6 | 232 | 10.7 | 99 | 7.3 | 230 | 2 | 240 | 8 | 6.7 | 3.00 | <0.01 | <0.01 | 0.05 | 0.10 |
| | | 9/17 | 1700 | 4.40 | 13.9 | 7.1 | 114 | 10.1 | 97 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |

*Samples analyzed after holding time.
**Upstream temperature = 14.6°C.

Table 3b. Cougar Creek survey - September 1986, analytical results for metals.

| Station | River Mile | Date | Time | Flow (cfs) | Copper (ug/L) | Zinc (ug/L) | Nickel (ug/L) | Chromium (ug/L) | Cadmium (ug/L) | Lead (ug/L) |
|---|---|---|---|---|---|---|---|---|---|---|
| 2.8 | 2.8 | 9/16 | 1350 | -- | <1 | <1 | <1 | <1 | <0.2 | 4 |
| 2.76D | 2.76 | 9/17 | 1530 | -- | 35 | 2500 | 14 | 2 | 2.2 | 21 |
| 2.4 | 2.4 | 9/16 | 1140 | 0.05 | <1 | <1 | <1 | <1 | <0.2 | <1 |
| | | 9/17 | 1245 | 1.40 | 6 | 64 | 17 | 4 | <0.2 | 3 |
| 2.25D | 2.25 | 9/17 | 1230 | 0.002 | 8 | 19 | 10 | <1 | 1.6 | 4 |
| 2.1D | 2.1 | 9/17 | 1220 | 0.002 | 13 | 17 | 2 | 3 | 0.3 | <1 |
| 1.82 | 1.82 | 9/17 | 0920 | -- | 15 | 34 | 5 | <1 | <0.2 | <1 |
| 1.56 | 1.56 | 9/16 | 1040 | 0.19 | 1 | <1 | <1 | <1 | <0.2 | 16 |
| 0.01 | 0.01 | 9/16 | 0905 | 1.00 | <1 | <1 | <1 | <1 | <0.2 | <1 |
| | | 9/17 | 0855 | 1.10 | <1 | <1 | <1 | 1 | 0.4 | <1 |

chloride concentrations at r.m. 2.8 (Table 3a) were found to be somewhat elevated, indicating a source; e.g., seepage from drainfields. On September 17 (high flow), nitrate concentrations were reduced to about 1/4 of the previous day's level, while the flow increased by a factor of about 27 at station 2.4. This indicates that a constant source of nitrate may be present. F.C. levels increased and were probably caused by runoff from the pasture to the east of the marsh. Class A F.C. standards were violated during both visits (Table 4) while D.O. concentrations only failed Class A standards during the high flow.

Between r.m. 2.8 and r.m. 2.75, the creek is bounded by a residential area on the right bank and a parking lot for a small business complex on the left bank.

A 12-inch cement culvert on the left bank at r.m. 2.76 was the most significant source of F.C. pollution identified during the survey. It passed beneath the parking lot, but its origin is not known. Flow from this discharge was impossible to determine because it was almost totally submerged in the creek. Class A F.C. and D.O. standards were both violated during the high-flow survey (Table 4). Runoff from other street drains during this survey exhibited similar characteristics: elevated ammonia, COD, temperature, and phosphate, and low pH. Also this discharge appears to impact the creek only during rain events. Data indicate no impact during low flow. The source(s) of the high F.C. contamination and elevated metals at this site are unknown. The Washington State University (WSU) experimental farm appears to be in the drainage area and might be a possible source.

The zinc concentration at this source was very high (Table 3b). Some zinc would be expected from highway and parking lot runoff since it is used in the production of tires, but the level measured at this site was not similar to other street and parking lot drains. The absence of appreciable quantities of nickel, chromium, and copper implies the source is probably not from a plating operation.

During the low-flow sampling, water quality at r.m. 2.75 exhibited the same problems as the upstream sample site at r.m. 2.8.

Reach between r.m. 2.75 and 2.4

Downstream of r.m. 2.75, the creek passes under a bank's parking lot, the old Pacific Highway, the parking lot adjacent to the B and M Transmission repair shop, and an apartment complex's lawn. Three or four parking lot drains are located directly above the channel between these points. During the September 15 reconnaissance of the area, a B and M Transmission employee was observed spilling transmission fluid in the parking lot just 50 feet from one of these drains. Gary Bailey of SWRO was notified and contacted B and M Transmission, requiring that they correct the problem. Oil was observed in the creek below this point on the September 17 visit. No sample was collected because by the time a check of the channel upstream could be made to pinpoint

Table 4. Class A (excellent) water quality standards (WAC 173-201-045) and characteristic uses.

| | |
|---|---|
| Characeristic Uses: | Water supply, wildlife habitat; livestock watering; general recreation and aesthetic enjoyment; commerce and navigation; fish reproduction, migration, rearing, and harvesting. |
| Water Quality Criteria | |
| Fecal Coliform: | Geometric mean not to exceed 100 organisms/100 mLs with not more than 10 percent of samples exceeding 200 organisms/100 mLs. |
| Dissolved Oxygen: | Shall exceed 8 mg/L. |
| Total Dissolved Gas: | Shall not exceed 110 percent saturation. |
| Temperature: | Shall not exceed $18^{o}C$ due to human activity. Increases shall not, at any time, exceed $t = 28/(T+7)$; or where temperature exceeds $18^{o}C$ naturally, no increase greater than $0.3^{o}C$. t = allowable temperature increase across dilution zone, and T = highest temperature outside the dilution zone. Increases from non-point sources shall not exceed $2.8^{o}C$. |
| pH: | Shall be within the range of 6.5 to 8.5, with man-caused variation within a range of less than 0.5 unit. |
| Toxic, radioactive, or deleterious materials: | Shall be below concentrations of public health significance, or which may cause acute or chronic toxic conditions to the aquatic biota, or which may adversely affect any water use. |
| Aesthetic Values: | Shall not be impaired by the presence of materials or their effects, excluding those of natural origin, which offend the senses of sight, smell, touch, or taste. |

the source, the discharge had ceased. Oil was again observed in the creek on May 13, 1987, during a visit to the site with Ecology inspector Dale Clark. It was traced to an unserviced oil trap in the drain on B & M Transmission's premises. An order to correct the condition within 30 days was issued by Dale Clark.

The channel opens for a distance of about 50 feet downstream of the apartment lawn, then passes under the I-5 freeway, and resurfaces adjacent to a shopping mall parking lot behind the King's Table restaurant. Several shopping carts were observed in the creek at this point, and chopped cabbage or lettuce had been dumped on the left bank. This parking lot drains to the creek. One drain behind a Safeway-affiliated store appeared to be used for dumping waste food products. A follow-up visit on May 13 with Dale Clark failed to identify whether the drain is connected to the creek. Downstream from the parking lot, the creek turns northwest, passing through a residential area. Several pipes from gutters and lawns were observed discharging runoff into the creek between the parking lot and r.m. 2.4.

Results at r.m. 2.4 site were similar to those upstream--Class A standards were not met for F.C. or D.O. on either day.

Reach between r.m. 2.4 and 1.56

Two 12-inch aluminum storm drains were encountered, one at r.m. 2.25 and one at 2.1 on the left bank. Loading from these two sources constituted less than 0.5 percent of the total load measured at r.m. 2.4 (Table 5). No apparent source for the elevated F.C. was observed. Newly constructed homes bordered the creek in the reach.

Homes on the right bank, down to r.m. 1.7, are older and located on larger parcels. These homes are on septic tanks (CCPSD, 1987). A sanitary sewer network (Cougar Creek intercepter) was observed extending down to 99th Street (r.m. 1.56) and possibly farther, but it is not known whether these homes are connected. Homes between r.m. 1.7 and 1.56 were newer, more closely spaced, and more likely to be on sewer. No home was located within 100 feet of the creek. Loading data for points between r.m. 2.4 and 1.82 do not suggest that failing septic systems are a serious problem.

On September 17, a foamy discharge was observed coming from the storm drain identified as station 1.83D. A work crew from the Clark County Road Department had been servicing this section of the storm sewer and may have been responsible for the foam. The discharge failed Class A pH standards and nearly caused the downstream station (1.82) to fail. Two other ditch drains (one 40 feet upstream and one directly across from station 1.83D) are located adjacent to N.W. 94th Street.

Water quality at r.m. 1.82 still failed Class A standards for F.C., but the D.O. level met the standard during low flow.

Six pipes were observed between r.m. 1.82 and 1.56 (Table 1). Only one pipe, at r.m. 1.59, was discharging during the low flow survey.

Table 5. Cougar Creek survey - September 1986 (values in lbs/day unless otherwise stated).

| Station | River Mile | Date | Time | Flow (cfs) | Chemical Oxygen Demand (lbs/day) | Chloride (lbs/day) | $NO_3$-N (lbs/day) | $NO_2$-N (lbs/day) | $NH_3$-N (lbs/day) | Total Inorganic Nitrogen (lbs/day) | Total Phosphorus (lbs/day) | Fecal Coliform Per Day |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2.75 | 2.75 | 9/16 | 1145 | 0.03 | 2.2 | 1.0 | 0.3 | <0.1 | <0.1 | 0.3 | <0.1 | 7.9E+08 |
| 2.4 | 2.4 | 9/16 | 1140 | 0.05 | 5.9 | 1.6 | 0.2 | <0.1 | <0.1 | 0.2 | <0.1 | 1.0E+09 |
| | | 9/17 | 1245 | 1.40 | 404.6 | 12.7 | 3.1 | 0.2 | 1.5 | 4.8 | 1.3 | 3.1E+11 |
| 2.25D | 2.25 | 9/17 | 1230 | 0.002 | 0.4 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | 8.4E+07 |
| 2.1D | 2.1 | 9/17 | 1220 | 0.002 | 0.5 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | 2.3E+07 |
| 1.82 | 1.82 | 9/16 | 1540 | 0.12* | 12.0 | 5.1 | 1.4 | <0.1 | <0.1 | 1.4 | 0.1 | 1.0E+09 |
| | | 9/17 | 0920 | 1.39** | 520 | 82 | 8.2 | 0.1 | 1.4 | 9.7 | 1.2 | 6.9E+10 |
| 1.59D | 1.59 | 9/16 | 1440 | 0.07 | 4.5 | 2.4 | 0.8 | <0.1 | <0.1 | 0.8 | 0.1 | 3.3E+09 |
| 1.56 | 1.56 | 9/16 | 1040 | 0.19 | 12.3 | 6.2 | 1.7 | <0.1 | <0.1 | 1.7 | 0.1 | 4.1E+09 |
| 0.53 | 0.53 | 9/16 | 1000 | 0.91 | 39.2 | 29.9 | 14.7 | <0.1 | <0.1 | 14.7 | 0.5 | 4.1E+09 |
| 0.01 | 0.01 | 9/16 | 0905 | 1.03 | 44.4 | 35.5 | 17.2 | <0.1 | <0.1 | 17.2 | 0.6 | 5.2E+09 |
| | | 9/17 | 0855 | 1.13 | 48.7 | 40.8 | 18.3 | <0.1 | <0.1 | 181.3 | 0.6 | 7.2E+09 |
| | | 9/17 | 1700 | 4.44 | | | | | | | | |

*Flow estimated from the difference between flows at r.m. 1.59D and 1.56.
**Flow estimated by using value from station 2.4.

At the time, it represented 37 percent of the total stream flow at r.m. 1.56. The F.C. load from this discharge represented 80 percent of the total F.C. load at r.m. 1.56. The source of this discharge is unknown.

At r.m. 1.56 the D.O. level met Class A standards, but F.C. did not. Runoff from roadside ditches enters the creek at this point. The ditches were not sampled; however, the impact of runoff at this point would be expected to be similar to that of stations 2.1D and 2.25D.

Reach between r.m. 1.56 and the confluence with Salmon Creek

Columbia High School is located on the left bank just downstream from r.m. 1.56. An 18-inch storm sewer, which originates in Hazel Dell Hollow, discharges into the creek near the high school (Clark County Health Department, 1977). Land use below r.m. 1.56 is a mixture of rural, residential, and one business (a slaughterhouse at r.m. 0.53).

Water quality at r.m. 0.53 failed Class A F.C. standards (Table 4). Chloride and phosphorus loads increased five-fold between 1.56 and this site (Table 5). Inorganic nitrogen loading increased by a factor of 8.6. Flow increased approximately five-fold. One resident indicated that a series of springs were located in this portion of the reach. The estimated concentrations from the unidentified source(s) in this portion of the reach are: 3.3 mg/L $NO_3$-N; 0.12 mg/L T-$PO_4$-P; 6.1 mg/L Cl; 12 mg/L COD. Bacteria did not appreciably increase in this reach.

Water quality at the Salmon Creek confluence and r.m. 0.53 were similar. D.O. saturation was 97 percent or greater during three separate visits (Table 3a). F.C. levels violated Class A standards. Flow increased four-fold between the morning and afternoon visits when only 0.83 inch of rain had fallen (Table 2). During the September 17 afternoon visit when flows were up, the creek was found to be carrying much more sediment than Salmon Creek.

## CONCLUSIONS

In general, discharges at r.m. 2.76D, 1.83D, and 1.59D had the most significant impact on water quality in Cougar Creek during the survey. The origin, a marsh that is surrounded by residential, agricultural, and light industrial influences, is also impacted. Commercial and possibly residential practices between r.m. 2.75 and 2.4 caused water quality problems within this portion of the drainage. No constant discharge was located, but careless garbage handling, oil spills by auto repair shops, and other, possibly deliberate, discharges of material causing the creek to turn blue or white had caused the majority of the water quality problems. The drain behind the Safeway-affiliated store would be a potential suspect for these discolorations if that drain empties into the creek.

During rain events, runoff from parking lots and ditches cause significant increases in COD, turbidity, and F.C. levels, with the discharge at r.m. 2.76 degrading water quality the most severely with respect to COD and F.C. pollution.

Between 2.4 and the confluence, runoff at r.m. 1.83 which was most likely related to activities by Clark County Road Department crews, and the continuous discharge at r.m. 1.59 caused significant degradation of water quality in this portion of the drainage.

Sources of discharges located between r.m. 1.56 and 0.53 are unknown. Elevated nutrient levels appear to be caused by ground water inputs. The reason for the relatively high ground water nutrient levels is not apparent.

## RECOMMENDATIONS

- Identify the sources influencing the water quality of drains at r.m. 2.76 and 1.59.
- Encourage Clark County to remove parking lot drains from direct discharge into the creek and provide pretreatment.
- Investigate the nature of the fill material used in the marsh at the origin and determine whether the land owners are in compliance with current regulations regarding the filling of wetlands.
- Contact the Safeway-affiliated store regarding its garbage handling and potential dumping practices.

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